the L-band measured by (B–L). Of course the first two physical parameters mentioned do vary over the pulsation cycle, and in this respect the Walraven photometer is very well adapted to the study of variable stars, because all five intensities are measured simultaneously. One important complication should be mentioned here: due to the existence of interstellar reddening one needs at least three two-colour diagrams for the determination of the physical parameters; this is apart from the important question of how to fix the zeropoint of the colour excesses.

Along these lines we have succeeded in measuring very accurately the blanketing in the ab-type RR Lyrae stars as was ascertained by comparing with, for example, Preston's Ca II K line strength parameter ΔS. Accurate metal abundances can now be attributed to over 200 stars and a study of various subgroupings in order to determine solar motion and statistical parallaxes is well under way.

Possibly even more interesting is the fact that we can derive temperature and surface gravity variations for all stars on our programme over their pulsation cycle. Several roads to study are thus opened. Combined with the light curve variation it is possible to determine the relative variation of radius for each star. Unfortunately only a few (one in our case), well-covered (and accurate!) radial velocity curves are available such that we might derive the actual radius excursion, and finally the radius and absolute luminosity—this is known as the Baade-Wesselink method. However, combining our knowledge of radius and temperature variation, it is possible to determine the temperature of the equilibrium state of a pulsating star.

Physical Properties of RR Lyrae Stars

A study of the period-temperature plane reveals several important properties of the field RR Lyrae stars: as a function of metal abundance, well-defined regions are discernible in Fig. 2. At a heavy element abundance $Z = 10^{-3}$ by mass (compared with $Z \simeq 0.02$ for the Sun) we derive in this way a helium abundance by mass $Y \simeq 0.25$ and a visual absolute magnitude $M_v \sim 0.5$. The high temperature boundary of the instability region provides another estimate of the helium abundance which also comes out at about the same value $Y \simeq 0.24$. The main uncertainty in such a determination resides in the accuracy of the adopted temperature scale: errors of up to 100 K are likely and lead to a change in the estimated helium abundance by about 0.025. The possible uncertainty in the theory is very difficult to estimate, but should be kept in mind.

The existence of such a clear division among the metal-poor RR Lyrae stars is reminiscent of the two subgroups which one finds among the globular clusters containing RR Lyrae variables. It will thus be of interest to extend the present work with measurements of the variables in some of the nearby clusters, which in principle is possible with a 1 m photometric telescope; such observations were indeed already made by J. Pousen in 1962 using the present equipment.

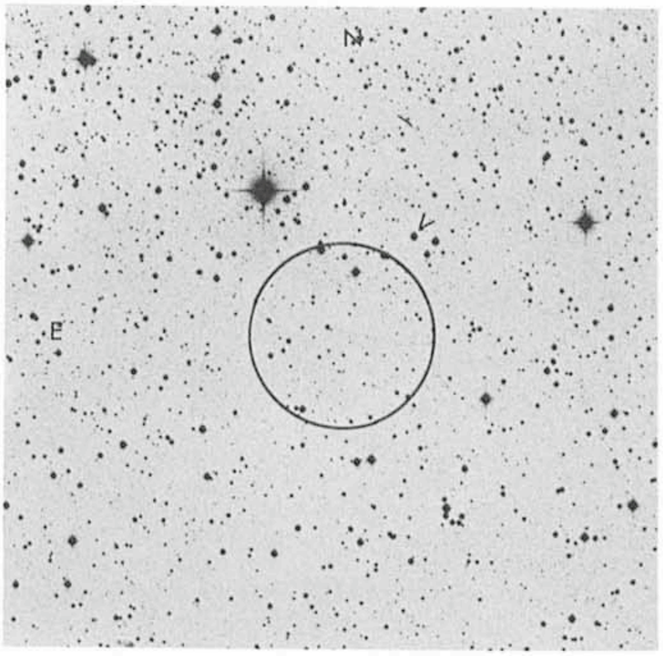
Optical Observations of Galactic X-ray Transients

M. Pakull

Dr. Manfred Pakull, of the ESO Scientific Group in Geneva, works on the optical identification of X-ray sources. During the past years, he has performed photometric and spectroscopic observations of stars near error boxes of X-ray sources. It is very difficult to be absolutely sure of an identification until synchronous variation of the X-ray and optical intensity has been demonstrated. He reports the possible identification of the transient X-ray source MX 0656-07, with a 12^m star.

The number of known X-ray sources in the sky increases rapidly. The latest compilation of sources observed by the pioneering UHURU satellite (4U catalogue) comprises more than 300 entries. Their distribution shows a strong concentration towards the galactic centre, proving that a large fraction of the sources belong to our galaxy.

Except for the X-ray emitting supernova remnants (SNR), most of the galactic sources are strongly variable on time scales of milliseconds up to years. Some sources suddenly



Error circle of MX 0656-07 superimposed on a print from the ESO (B) Atlas. The Be star mentioned in the text is marked by the V.

brighten up from invisibility to become the most luminous objects in the X-ray sky for a few days and subsequently decline below the threshold of the detectors. They are commonly referred to as X-ray Novae or Transients.

And, indeed, the X-ray novae A 0620-00, TrA X-1 and H 1705-25 have been identified with optical novae. These three sources share many characteristics, as for instance soft X-ray spectra and lack of regular X-ray pulsations. Moreover, the transient A 1744-36 might correspond to the optical nova Hen 1481. It appeared in 1951 at the position of the X-ray source. If this identification is correct A 1744-36 is a recurrent X-ray/optical nova like A 0620-00.

Another class of transients display very hard spectra and mostly regular X-ray pulsations. No corresponding optical novae have been observed at their positions. A 0535+26, 4U 0115+63 and A 1118-60, the "X-mas" source (since it flared up on Christmas 1974), belong to this group. There is now growing evidence that they might be related to Be stars, early-type main-sequence stars spinning at their break-up velocity.

Unfortunately, positions of most transients are not very accurately determined. Therefore the chance of accidental associations should be kept in mind.

Be stars are, however, also found as optical counterparts of persistent X-ray sources, notably 4U 0352+30 = X Per, MX 0053+60 = γ Cas and 4U 1145-61 = Hen 715.

Observations on La Silla

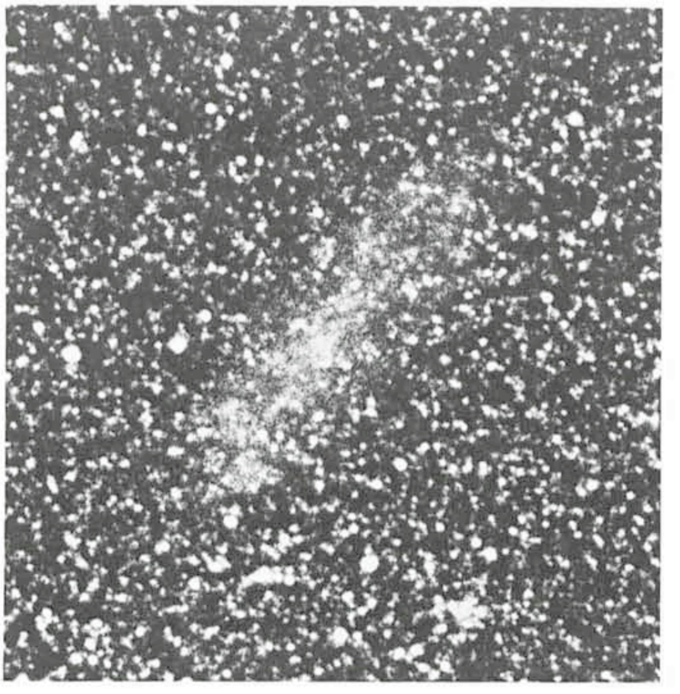
A number of X-ray error boxes have been observed during the last two years with the ESO 50 cm, 100 cm and 152 cm telescopes. An early-type star like a Be star might easily be detected by means of UBV photometry, even on nights of poor photometric quality. Subsequent observations of candidates, however, need "good" nights to detect variations, which could be less than 0.05 magnitude.

The proposed identification of the transient MX 0656-07 with a Be star may serve as an illustrative example. This source was detected by the SAS-3 satellite in September 1975. Subsequently, Schmidt and Angel searched in vain for a corresponding new star. Later the position was refined by Ariel 5 to a 90 per cent error circle of 3 arcmin radius, which made a photometric survey feasible.

UBV photometry of about 20 stars revealed a reddened early-type star of visual magnitude V = 12.35 and colours (B – V) = 0.87, (U – B) = –0.16 with possible variations of a few hundreds of a magnitude in the following nights.

In January 1978, Dr. West kindly took two short-exposure, 123 Å/mm spectra with the 3.6 m telescope confirming the early spectral type of about B2. Hα and Hβ are clearly seen in emission and the presence of many strong interstellar lines confirms the high reddening of $E_{B-V} = 1.0$. Spectroscopic observations with higher resolution and more photometry are planned to determine its luminosity and to reveal possible periodic light variations as seen in most X-ray binaries. As was mentioned earlier, the possibility of a chance coincidence cannot be ruled out completely, although the apparent density of Be stars in this direction of the galactic plane turns out to be quite low.

Future observations, preferably to be carried out simultaneously in the X-ray and optical band, and the possible detection of transients at a very low level with more sensitive satellites as HEAO-B will help us to understand the underlying mechanisms of X-ray outbursts in these most interesting systems.



NGC 1809: Behind the LMC

▲

The object NGC 1809 has long been known. It lies southwest of the central bar in the Large Magellanic Cloud and is apparently heavily obscured by the LMC stars. The photo is reproduced from ESO Quick Blue Survey plate No. 1133 of field 56, which was obtained in 1975 with the ESO Schmidt telescope. It shows NGC 1809 as an elliptical nebula with a central condensation.

It is obviously rather difficult to obtain a spectrum of this object, due to the large number of LMC stars. Nevertheless, a 20-min 123 Å/mm spectrum with the Cassegrain spectrograph on the 3.6 m telescope just shows some weak emission lines on top of the heavy LMC stellar background. The velocity is about 1,000 km/s, much too high to make NGC 1809 a member of the LMC. It is therefore a galaxy behind the LMC, shining dimly through the absorbing layers of dust in the LMC. It is also possible that NGC 1809 is associated with a radio source in the most recent Parkes catalogue of southern radio sources.

The detailed results are being published in a note in Astronomy and Astrophysics by ESO astronomer R. M. West.

The Large Magellanic Cloud in Infrared Light!

Deep plates of the Magellanic Clouds are presently being compiled at the European Southern Observatory, by means of the 1 m Schmidt telescope. On page 19 we show the Large Cloud as it looks in infrared light (7000–9000 Å) on a unique IV-N plate, obtained on January 16, 1978, behind a RG715 filter. The exposure time was one hour. The plate was sensitized and guided by Guido Pizarro. The plate is remarkable because of its uniformity; normally it is very difficult to hypersensitize infrared plates without the risk of large non-uniformities. Water (H_2O) and ammonium (NH_3) were used for this plate.

It shows mainly the redder stars in the LMC and suppresses the gaseous nebula. The stars are resolved even in the central part of the bar. The nebula to the upper left is 30 Doradus, the brightest H II region in the LMC. ▶